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Research Article

Noise Pollution Exposure Among Nurses in a Public Hospital in Palestine

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Abstract

Noise pollution affects our health adversely. At hospital, noise can harm health care professionals and patients too. It also affects the performance of the whole staff and therefore, the quality of the delivered services. This study aimed to assess noise levels nurses exposed to and to determine the sources of noise and nurses' complaints about it. A quantitative, descriptive cross sectional study was used. Noise levels at different departments in Palestine Medical Complex (PMC) were measured using an integrating sound level meter. A total of 180 nurses participated in the interviewing questionnaire. The results of the study showed that main sources of noise were: the loud arguments occurred between the health care staff and the relatives/visitors of the patients, loud conversations, the construction work and the renovation in the hospital, patients' crying/shouting, the medical equipment and the staff shouting. The main complaints were discomfort, bad communication, headache, fatigue, stress, irritability, low concentration, inattention, memory problems and noise effect on work efficiency. In most departments, morning shift was the noisiest shift and nurses (61.1%) considered work environment stressful and uncomfortable. Noise levels in all departments exceeded what is recommended by WHO with an average of 64.48 dBA. The minimum value of LAeq was 54.8 dBA in one CCU and the maximum one was 73.5 dBA in NICU. Conclusion: Different noise sources at PMC and many noise complaints were reported by nurses. Noise levels in different departments were above that recommended by WHO. The educational intervention should target nurses and the whole health care staff in order to increase their awareness about noise and to modify their behaviors to reduce it, as well as the effective management of medical devices and machines, repairing devices and physical space arrangement.

Keywords

Noise Pollution, Hospital Noise, Nurses, Noise Sources, Noise Effects, Noise Levels

1. Introduction

Noise was defined as undesirable sound or any sound which is unfavorable and causes annoyance or disruption of performance and is considered as stressful from both psychological and psychological sides [1]. To consider the sound as noise, it depends on the sound acoustical properties and also on the interference sound can have with the intended activities [2]. The sensitivity to sound differs from one person to another and thus, we are not affected equally when

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exposed to the same noise and also the effect is not in the same way if we are at home and if being at work too [3]. At present, noise becomes a serious problem globally and it has been proven that being subjected to high levels of noise is a health risk for the human beings, the animals and the entire ecosystem [4]. It has been known that noise exposure leads to hearing loss since a long time, but the bad effects it has on our cardiovascular system, nervous system and endocrine system as well as the sleeping disorders have been confirmed recently [5]. The psychological effect that people mainly suffer from as a result to environmental and occupational exposure to noise is the annoyance [6].

Last decades, there was a tendency in the environment of the hospitals to become noisy and levels of noise were more than the recommended levels by the World Health Organization (WHO) and the Environmental Protection Agency (EPA) [7]. WHO recommends 30-40 decibels (dBA) for indoor hospitals while EPA recommends not exceeding 45 dB through the day and 35 dB through the nighttime [8]. Noise at hospitals may harm psychologically and physically the nursing staff as well as the patients but the effect is much more on nurses since they spend longer time there [7]. Studies have been conducted in different hospitals at different locations to measure levels of noise. Costa et al. (2013) undertaken their study in a public hospital in Brazil and measured noise levels at different sectors and they were all more than the recommended levels [8]. The noise levels in different departments in another public hospital at Governador Valadares, appeared to be more than what is recommended by WHO [9]. In some hospitals in Taiwan, daily average noise levels through the day exceeded 50 decibels which is the noise limit set there [10].

Noise levels in intensive care units (ICUs) in many reviewed studies were more than WHO and EPA recommendations and the major noise sources in the ICUs and other departments were due to operating equipment and human activities [11]. The ICUs seems to be the noisiest areas in hospitals which may worsen the outcomes in the patients. In two surgical ICUs in a hospital in Boston, the levels of sound exceeded the recommended levels by WHO and EPA in all times and were due mainly to environmental factors [12]. In the pediatric ICU at Women and Children' Hospital of Buffalo, the recorded noise levels were more than 70 and 80 dB (A) and the peak noise level was higher than 100 dB (A) [13]. Another study was conducted in three different specialties pediatric ICUs at a public hospital and the average noise level there was 71.9 dB (A). The most common noise sources in those units were the communications between staff, activities of care and patients' rooms [14]. Noise levels in 10 different ICUs were measured in another study and the highest levels were found in the neonatal, cardiovascular surgery and neurology ICUs and were above that recommended in all units. That study revealed that noise level had an effect on the extrinsic satisfaction of nurses and affected their anxiety levels [15].

Levels of noise during the morning, the afternoon and the evening periods in the emergency department (ER) of a general trauma hospital in Curitiba were measured and the afternoon time was the noisiest and the levels in all measured indoor points were more than the comfort levels the Brazilian Association of Technical Standards recommended in 1987. Such levels may hurt the health of patients and professionals and also affect the performance of the professionals [16]. Hemodialysis centers suffer from noise pollution as noise levels of more than 100-110 dB can be recorded there. The noise levels peak happen at the beginnings of the dialysis shifts or at the end of them [17]. Nephrology department and other departments were also investigated for noise levels in the Imam Reza Hospital in Iran and the average level (Leq) there was quite more than the standard level and Nephrology department and the ER units were the noisiest areas in different hours of the shift [18].

Tsiou *et al.* (2008) in Greece reported that sound pressure levels of noise varied for each operation and according to noise sources and that levels measured at operating rooms were in excess that required an effective improvement of environment [19]. Surgical and medical units of a three health care facilities were also investigated for noise levels and the average daytime and nighttime measurements in patient rooms and nursing stations were more than the WHO recommendations [20].

Some studies investigated the knowledge of nurses and other health care providers towards noise have revealed poor results and lack of knowledge among them. In ICUs, the nurses showed limited awareness regarding noise issue and their knowledge about noise and its adverse effects was poor [21, 22]. In Brazil, some studies showed how effective the role of the educational programs that focused on the bad effects caused by noise and the behavioral changes to reduce it was effective in lowering the levels of noise than they were before doing the intervention [23, 24]. But behavioral modifications that nurses adopt to have control on the too much noise are not sufficient alone and to be more effective, the machines and the alarms of medical devices should be managed effectively in addition to the ongoing process improvement plan [25]. It is proved that elevated noise levels are high in hospitals in everywhere and that these levels negatively affect the whole health staff as well as the patients. Thus, there is a need to investigate the noise pollution issue in hospitals in Palestine. The present study was conducted to assess noise levels that nurses exposed to in different departments and to determine the sources of noise and noise complaints as nurses perceived them. Also, to provide recommendations that would help in having a suitable work environment.

2. Materials and Methods

2.1. Study Design

A quantitative, descriptive cross sectional study was used.

2.2. Study Setting and Population

The study was undertaken in Palestine Medical Complex (PMC) which is located in Ramallah and al-Bireh governorate in West Bank. PMC exists in downtown Ramallah which is a quite busy area. It belongs to MOH and consists of 4 main wings. Seven departments were included from Ramallah Sons wing; ICU, Cardiology and Catheterization, Cardiac Care Unit (CCU), Operation department, Internal Medicine and General Surgery departments in addition to the Kidney department which is existed in a separated building. From the Emergency Wing, the departments of Orthopedic and adult ER were taken. Departments of Pediatric ICU, Neonatal ICU, Internal Medicine and Pediatric ER were taken from Pediatric Wing. The Specialized Surgeries department and the CCU were included from Cardiac and Specialized Surgeries Wing. An adequate number of nurses from the different departments were included in the study. The employment duration of the participated nurses in the Ministry of Health (MOH) was one year and more.

2.3. Ethical Considerations

An approval was obtained from the executive manager of PMC in addition to the ethical approval obtained from Helsinki Committee in Palestine. Each questionnaire had an explanatory letter attached to it as an informed consent in order to keep the rights of the participants. Nurses' participation in the study was optional.

2.4. Data Collection

The questionnaire was developed by the researcher. It covered socio-demographic factors and included a checklist for known noise sources to choose among them the ones nurses perceive as noise sources in their working department. Also, there was a question including several complaints known to be caused by noise pollution and nurses reported which ones among them they experience at their workplace. They were also asked how they perceive the noise levels at their departments and their work environment. Participated nurses were interviewed via face to face by the researcher using the same questionnaire which took approximately 15-20 minutes to be filled.

Integrating sound level meter (ST-106 CLASS 1) was used to measure A-weighted equivalent continuous sound pressure level during a stated time interval (LAeq,T) in different departments. The device was calibrated before starting the measurement, the measurement band was between 30 dBA -130 dBA. The device was put in a fixed place in each department and near to the nurse station and was positioned at 1.5m from the ground. The readings were taken for morning shift starting from 7:00 am to 2:00 pm. At the end of the morning shift, the LAeq was taken for each department. Noise levels were measured for two morning shifts in each department and the mean was taken.

2.5. Statistical Analysis

Statistical Package for Social Sciences (SPSS) software was used (version 25). Data were coded and computerized. Appropriate statistical methods were applied for the study variables.

3. Results

3.1. Characteristics of Study Subjects

180/186 (96.8%) nurses from different departments were subjected to the interviewing questionnaire. The males represented 56.1% of them. The ages of most nurses were below 37 years and the average age was 32.5 (SD=6.88). The majority of nurses (80.6%) were registered nurses. 70% of the participants had a Bachelor's Degree and those with Master Degree and nursing Diploma in different specialties post the Bachelor's Degree represented 10.0%. The experience in nursing field for 60% of the participants was ≤ 10 years while 7.8% of them had an experience > 20 years.

3.2. Noise Sources in Different PMC Departments

Nurses chose from noise sources' checklist the ones they perceived as noise sources in their working department. Main sources were loud arguments with the relatives of the patients and their visitors, the construction work and the renovation, visitors' conversation, the ringtones, patients crying and shouting, the loud arguments outside departments with the patients' visitors and relatives in addition to the medical equipment. The conversations between the co-workers, the shouting of both medical and nursing staff, the noise produced through the shift change, children playing, the vehicle traffic and the cleaning personnel were also sources of noise in PMC. Doors opening and closing, the doorbell and the rolling of trolley wheels were mentioned too in less percentage (Table 1). 34% of nurses added gun fire, 26% added loud songs from parties near to PMC area and 28% reported fireworks.

Table 1. *Noise sources in different PMC departments as perceived by participants.*

Item	No.	%
Cardiac monitors	83	46
Other medical equipment	112	62
Conversation of patients' visitors	139	77
Children playing	91	51
Patients moaning or crying/shouting	124	69

Item	No.	%
Co-workers conversations	106	59
Shouting of nursing staff	105	58
Shouting of medical staff	98	54
Shift change of nursing staff	100	56
Door bell	85	47
Doors opening or closing	74	41
Ringtones (phone ringing)	129	72
Rolling of trolley wheels	82	46
Cleaning personnel	90	50
Loud arguments with patients' relatives and visitors	150	83
Construction work and renovation	139	77
Loud arguments with patients' relatives and visitors outside departments	123	68
Vehicle traffic	99	55

3.3. Nurses Complaints Regarding Noise

The majority felt discomfort, stressful and found difficulty in hearing others. Many of them had to talk louder to be heard. 24% suffered from tinnitus, 31% experienced dizziness and 35.6% had difficulty in sleeping after a working day. Many nurses suffered from headache, fatigue, irritability, low concentration, difficulty in paying attention and about a half had memory problems. 66% of nurses had anxiety and 24% felt depressed. 39% reported that they were subjected to the risk of patient care errors due to noise but it was rarely and 74% reported that noise affected their work efficiency (Table 2).

Table 2. *Noise complaints as reported by nurses in different PMC departments.*

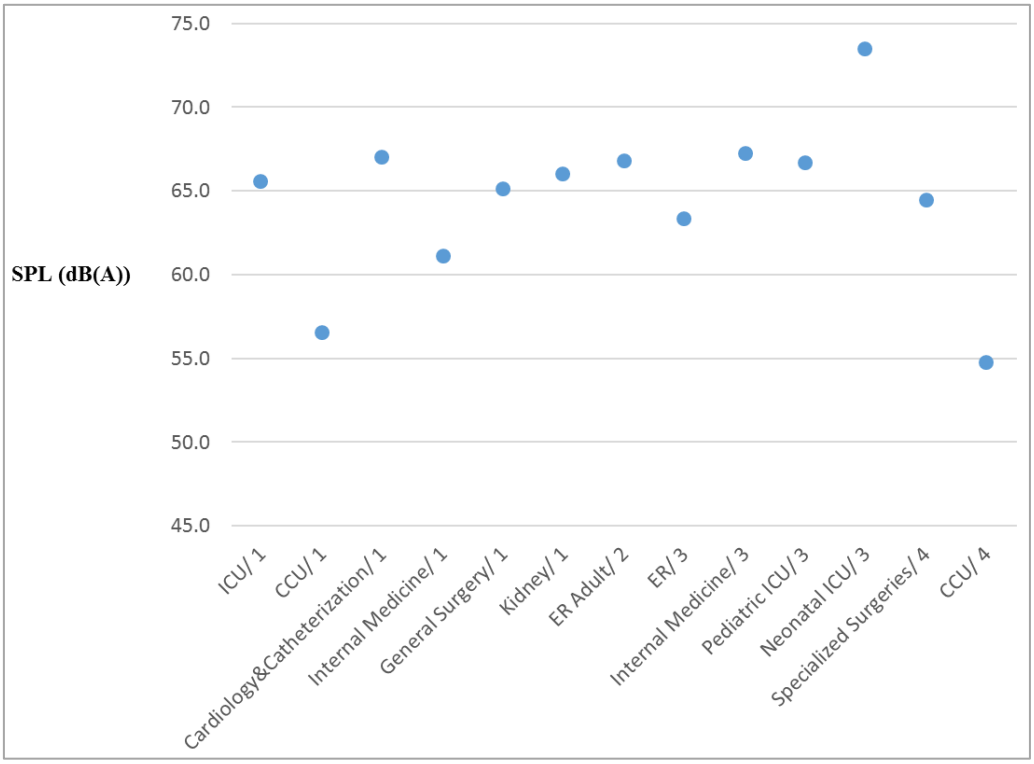
Item	No.	%
Discomfort	175	97
Had to talk louder to be heard	154	85.6
Difficulty in hearing others due to noise	159	88.3
Tinnitus	43	24
Dizziness	57	31.7
Headache	137	76.1
Fatigue	135	75
Difficulty in sleeping after leaving work	64	35.6
Stress	163	90.6
Anxiety	119	66.1
Irritability	139	77.2
Depression	44	24.4
Low concentration	130	72.2
Difficulty in paying attention	133	73.9
Memory problems	85	47.2
Subjected to the risk of patient care errors	70	38.9
Work efficiency is affected	133	73.9

3.4. Nurses' Perception Regarding Noise Levels and Their Work Environment

Nurses (80.6%) perceived noise levels to be high during the morning shift, 17.2% perceived it as neutral and only 2.2% found it low. 53.3% of nurses found noise levels high in the evening shift while 37.2% thought it was neutral. The noise levels in the night shift were perceived low by about 52% of nurses, neutral by 29% and high by 19%. In terms of noise, 61.1% of nurses perceived their work environment as uncomfortable and stressful one, but 7.2% perceived it as comfortable and the remaining 31.7% were neutral.

3.5. Noise Levels in Different Departments During Morning Shift

Noise levels (LAeq) were measured during morning shift in thirteen departments. The minimum value of LAeq (54.8 dBA) was found in CCU located in the Cardiac and Specialized Surgeries Wing while the maximum value (73.5 dBA) was recorded in the NICU. The noise levels in the PICU, Internal Medicine and ER departments of the Pediatric Wing were 66.7 dBA, 67.2 dBA and 63.3 dBA respectively and found to be 66.8 dBA in the adult ER. In the ICU, CCU and Cardiology and Catheterization department in Ramallah Sons (RS) Wing, the noise levels were 65.6 dBA, 56.6 dBA and 67 dBA respectively. Noise levels were 61.1 dBA in the Internal Medicine, 65.1 dBA in the General Surgery and 66 dBA in Kidney department. The LAeq was 64.5 dBA in Specialized Surgeries department in Cardiac and Specialized Surgeries Wing (Figure 1). Average LAeq in all departments was 64.48 (SD=4.81).



1=Ramallah Sons Wing; 2=Emergency Wing; 3=Pediatric Wing; 4= Cardiac and Specialized Surgeries Wing

Figure 1. *Noise levels (LAeq,T) in different departments during the morning shift.*

4. Discussion

A slight predominance for males was found among nurses working in different departments. According to WHO, about 90% of the nursing workforce globally are females [26]. No female predominance among nurses in PMC may be due to cultural and social reasons which constrain or decrease the females engaging in nursing field. It was noticed that most participants were young while most nurses in the Brazilian study were 40 or more years old [8]. The reason for this result was the transfer of many nurses who had many years of experience from PMC to other governmental hospitals and also the increased employment rate in MOH for the graduate nurses. Regarding job title, highest qualification obtained and years of experience, the majority were registered nurses with bachelors' and few of them had an experience over 20 years since most nurses were young. This differed from Costa and others study, where the percentage of nurses was 22.46% and the remaining were nurse assistants and nurse technicians and 49% had an experience of 20 years and more [8].

In the present study, the noisiest source that most nurses reported was the loud arguments occurred inside the departments and outside them between the health staff and the patients' relatives/visitors. The culture and the nature of some people could be the reason for that and also the stressful conditions that people in Palestine suffer from in their daily life might make them impatient, stressed and getting nervous rapidly. Other sources reported by nurses were the medical equipment, the conversations of the co-workers and the visitors' conversations and those sources were major noise sources in previous studies [11-27]. Cardiac monitors and other medical devices were indicated mainly by most nurses working in CCUs, ICUs, adult ER and the Kidney department and also by some nurses working in the operation department. Many of them mentioned being bothered by loud conversations of the patients' visitors in patients' rooms, at corridors and near nursing stations. They also pointed to the fact that visitors didn't adhere to the date of visit and to the number of visitors allowed. All nurses in adult ER suffered from loud conversations due to large number of victims' families gathered inside that made department very crowded and noisy as reported by Filus and others [16]. The construction work and the renovation inside the hospital, crying/shouting of patients, shouting of nurses, children playing and doors opening and closing were mentioned too as noise sources in PMC and this also agreed with another study [10]. The noise coming from gun fire was due to the fact that some people used to shoot in many different occasions. Hearing loud songs from parties outside and the use of fireworks were other noisy sources that disturbed some nurses when happening.

Main complaint reported by nurses was discomfort to loud noise and this agreed with Andrade and others study [9]. Some nurses complained from tinnitus, dizziness and diffi-

culty in sleeping after leaving the work and most of them experienced headache while less percentage of nurses experienced headache, tinnitus and dizziness and more nurses experienced sleeping difficulties appeared in another study [8]. Many felt stressful and suffered from fatigue, irritation and low concentration and this agreed with findings revealed by Ryherd and Waye study [28]. Nurses also experienced anxiety due to noise this complaint appeared in Terzi and others study [15]. About quarter of nurses felt depressed by noise and depression was reported as one of the morbid conditions resulted from exposure to high noise levels [17].

In the present study, most of the nurses suffered from low concentration and inattention and some suffered from memory problem in experiencing work in addition to noise interference with communication. This agreed with Katz (2014), who reported that noise interfered with communication and work concentration [29].

Noise exposure affected the performance of nurses in PMC since most of them reported that their work efficiency was affected by noise and some mentioned their subjection to the risk of care errors and this agreed with previous studies that mentioned the noise effect on their performance [16, 17]. Nurses working in ER suffered more than others from headache and depression and irritability. It is worth to indicate that 21.1% of nurses mentioned having a problem in hearing well and such complain was shown in Andrade and others study [9]. Hearing problem was mentioned more by nurses working in Kidney department who also experienced fatigue more than others. The highest percentage of nurses experienced difficulty in sleeping after a working day found in ICUs.

Most nurses perceived the levels of noise to be high during the morning shift while about half of them found it high during the evening shift and only 19% perceived them high during the night shift. More number of nurses in different departments perceived the morning shift as the noisiest shift within the workday and about half of nurses considered the night shift as the quietest one. The work environment in terms of noise was considered stressful by many of nurses (61.1%), and few of them (7.2%) considered it comfortable and this is a worrying indicator which may reflect burnout tendency among employees.

In the present study, average noise level in all departments at PMC was 64.48 dBA (SD=4.81). The levels of noise in the selected departments exceeded what was recommended by WHO as other studies revealed [9-20]. In all departments, the LAeq was more than 60 dBA except for CCUs where it was 54.8 dBA and 56.6 dBA. This result agreed with Khademi and others result as the noise level in CCU wards was 54-56 dB [18]. In ICUs, the recorded noise levels were mainly due to medical equipment and staff activities as previous study revealed [11]. The NICU had the highest noise level which was 73.5 dBA and this agreed with Terzi and others result [15]. In addition to the medical equipment and staff activities as main noise sources in NICU, there was construction work in the Pediatric Wing during the time of taking measurements. The adult ICU had the lowest noise level among ICUs but nurses reported that department was usually noisier and that result might due to the restrictions done on the visits in responding to COVID-9 safety precautions.

In Kidney department, it was observed that the department became noisier at the beginnings and the endings of the dialysis shifts as mentioned in another study [17]. Also, it became so noisy during shift change of nursing staff due to staff gathering and their loud conversations. The noise level in adult ER was 66.8 dBA and the department got noisier in the last hours of the morning shift between 12 pm and 2.00 pm. Nurses pointed that their department became noisier in the afternoon hours and afternoon period also found to be the noisiest one in the ER in another study [16]. The ER departments were calmer than their usual times as told by nurses informally due to the restrictions during COVID-19 times. The Internal Medicine department in the Pediatric Wing had the highest noise level due to the construction work.

5. Conclusion

Noise was generated from different sources; mainly the health staff loud arguments with visitors, renovation and construction work, loud conversations between staff and between visitors, the medical equipment, ringtones, patients' shouting and others. As a result to noise exposure, nurses complained from discomfort, bad communication, fatigue, stress, anxiety, headache, irritability, low concentration and inattention, memory problems, and their work efficiency was affected. Nurses (61.1%) considered work environment stressful in terms of noise. Noise levels during morning shift in different departments at PMC exceeded the WHO recommended levels. Departments' average noise level was 64.48 dBA, and the levels were > 60 dBA in all departments except in CCUs where it was 54.8 dBA and 56.6 dBA. NICU had the highest noise level which was 73.5 dBA.

6. Recommendations

It is essential to raise the awareness and increase the knowledge towards noise pollution among the whole health care staff through the educational program. Also, it is a must to deal with modifiable noise sources in order to decrease the levels of noise at health institutions. This will maintain the health of nurses and patients and will ultimately affect the quality of care provided.

Abbreviations

WHO	World Health Organization
EPA	Environmental Protection Agency
ICU	Intensive Care Unit

ER	Emergency Room
PMC	Palestine Medical Complex
CCU	Cardiac Care Unit
MOH	Ministry of Health

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Author Contributions

May Ahmed ElAfifi: Conceptualization, Methodology, Investigation, Project administration, Resources, Writing original draft, Writing-review& editing

Mohamed Yehia ElAwady: Conceptualization, Data curation, Formal analysis, Writing-review& editing

Ayesha Mohammed AlRifai: Methodology, Writing-review& editing

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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